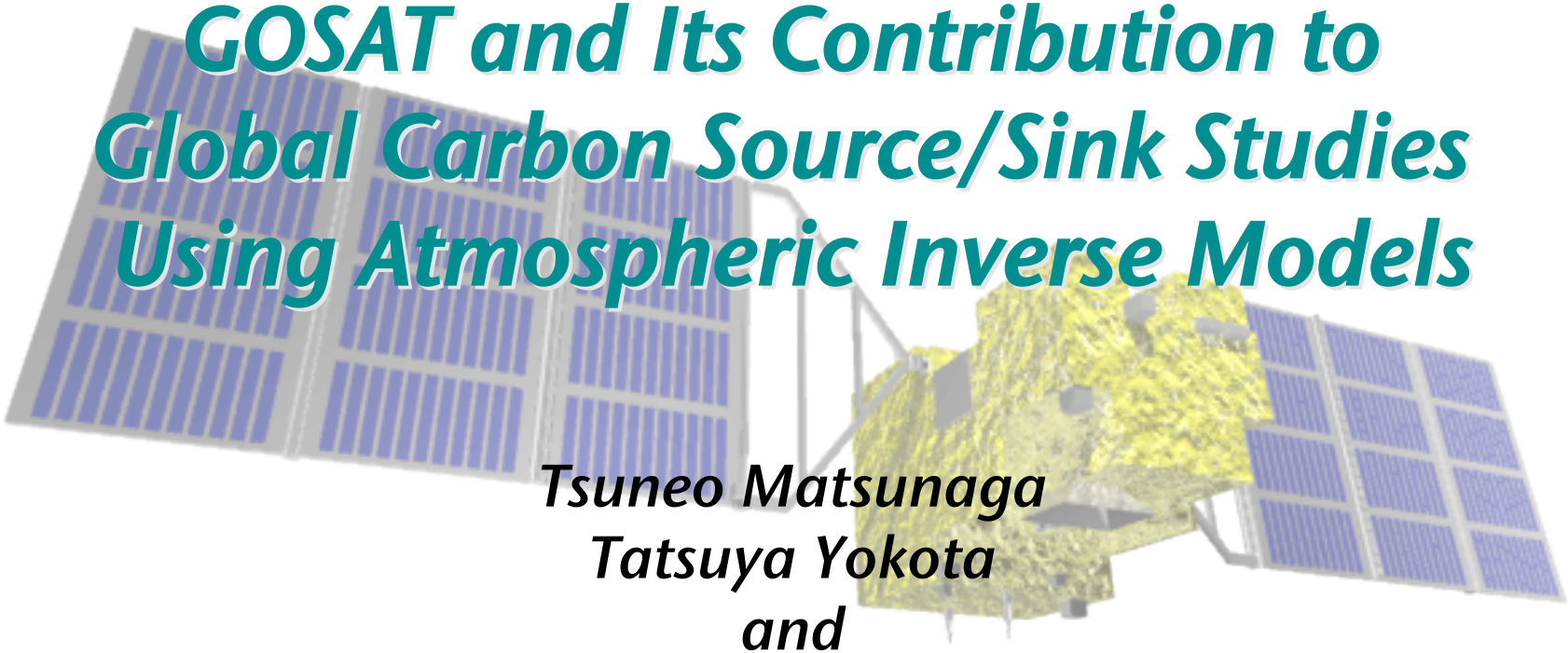
Monitoring and Predicting Climate Change
- Needs from Carbon Cycle Modeling -

GOSAT and Its Contribution to Global Carbon Source/Sink Studies Using Atmospheric Inverse Models



Tsuneo Matsunaga
Tatsuya Yokota
and
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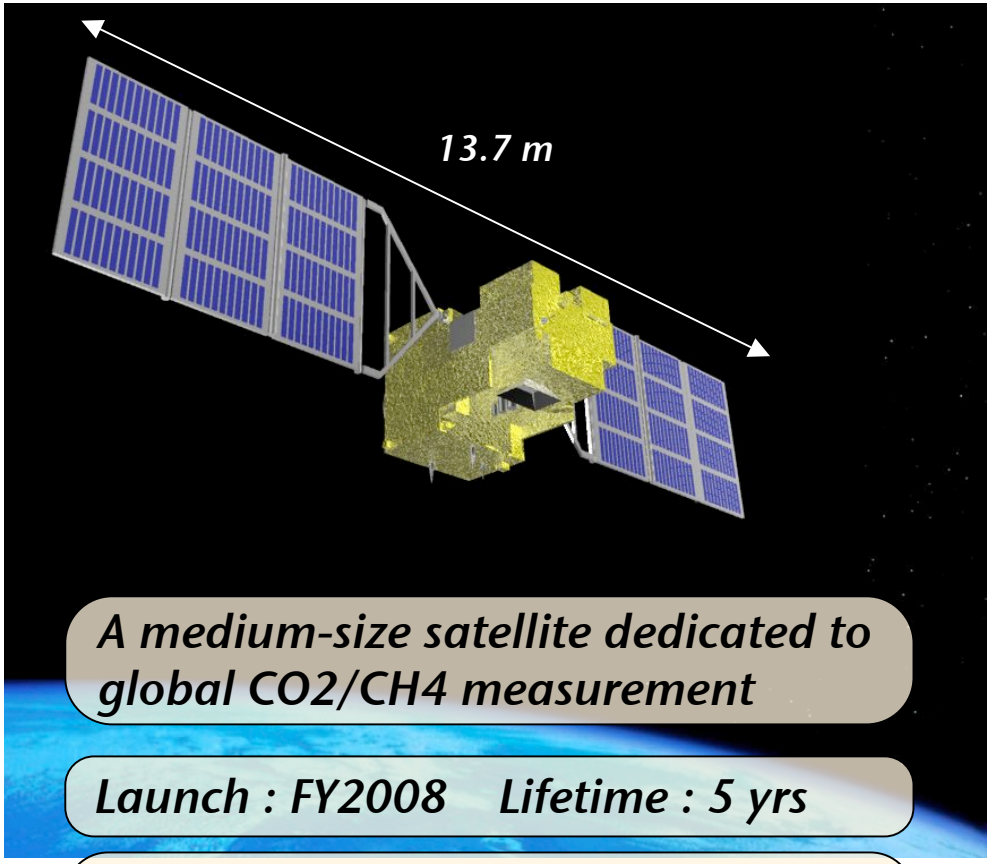
National Institute for Environmental Studies(NIES)
Japan

Greenhouse gases GOSAT PROJECT Observing SATellite

Greenhouse Gases Observing Satellite(GOSAT)



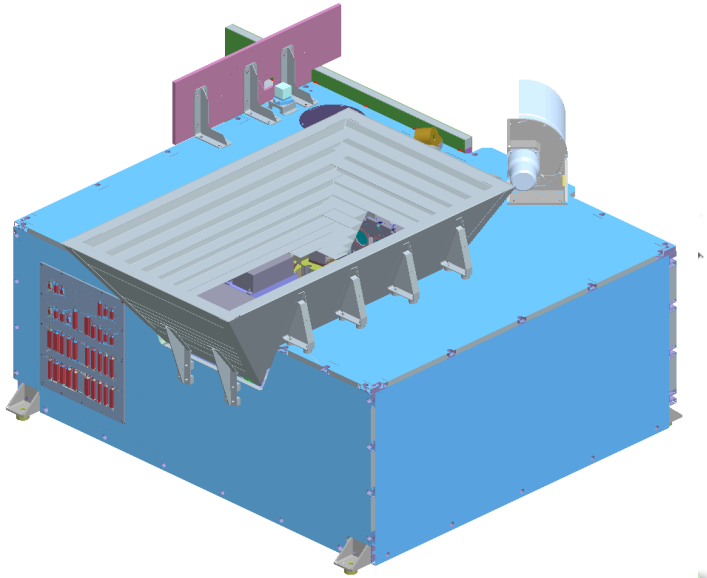
A medium-size satellite dedicated to global CO2/CH4 measurement

Launch : FY2008 Lifetime : 5 yrs

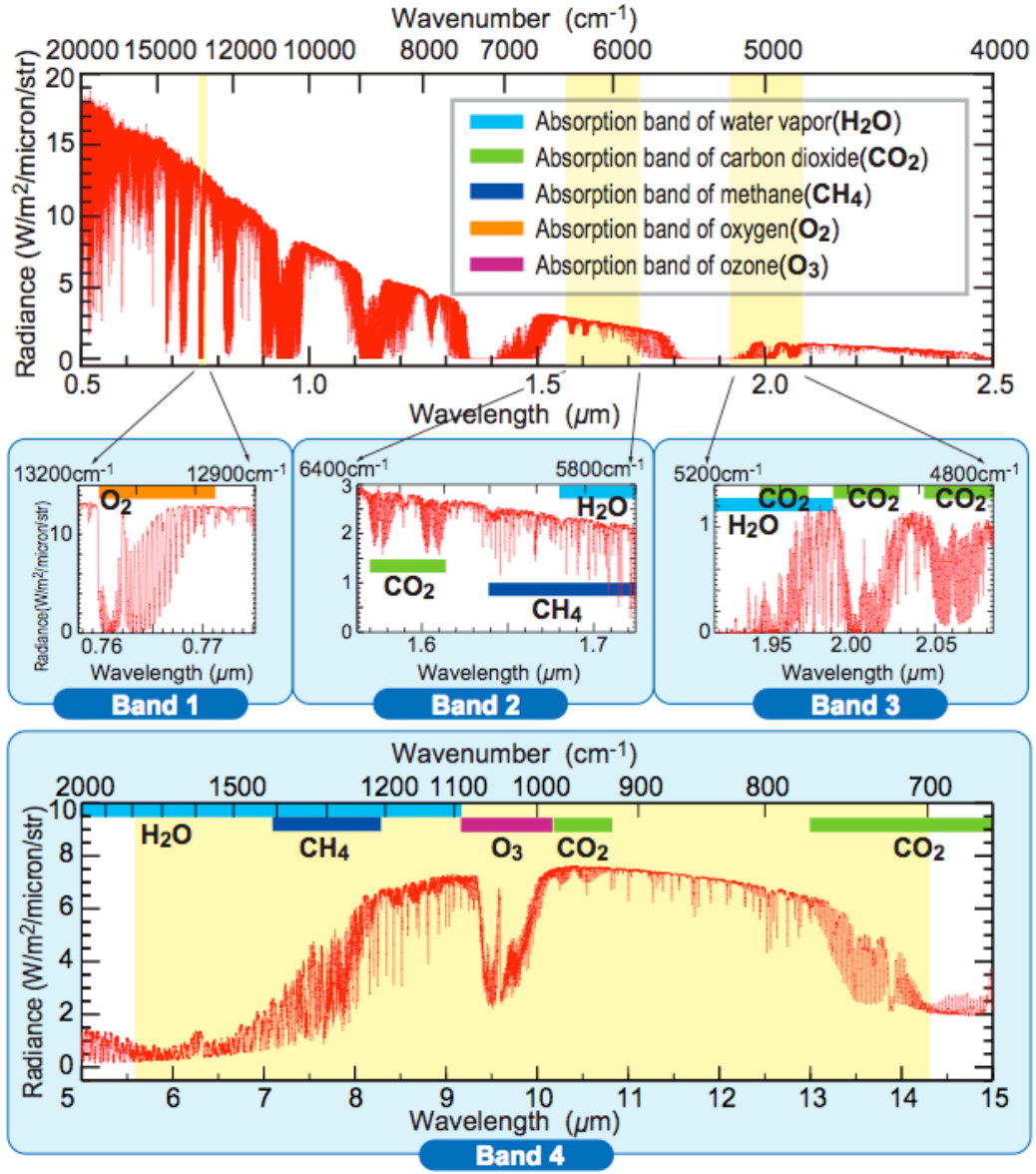
Altitude : 666 km
Repeat Cycle : 3 days
Equator crossing time : 13:00
Instrument(1) : Fourier Transform Spectrometer
Instrument(2) : Cloud-Aerosol Imager

A JAXA-MOE-NIES joint mission with GOSAT Science Team

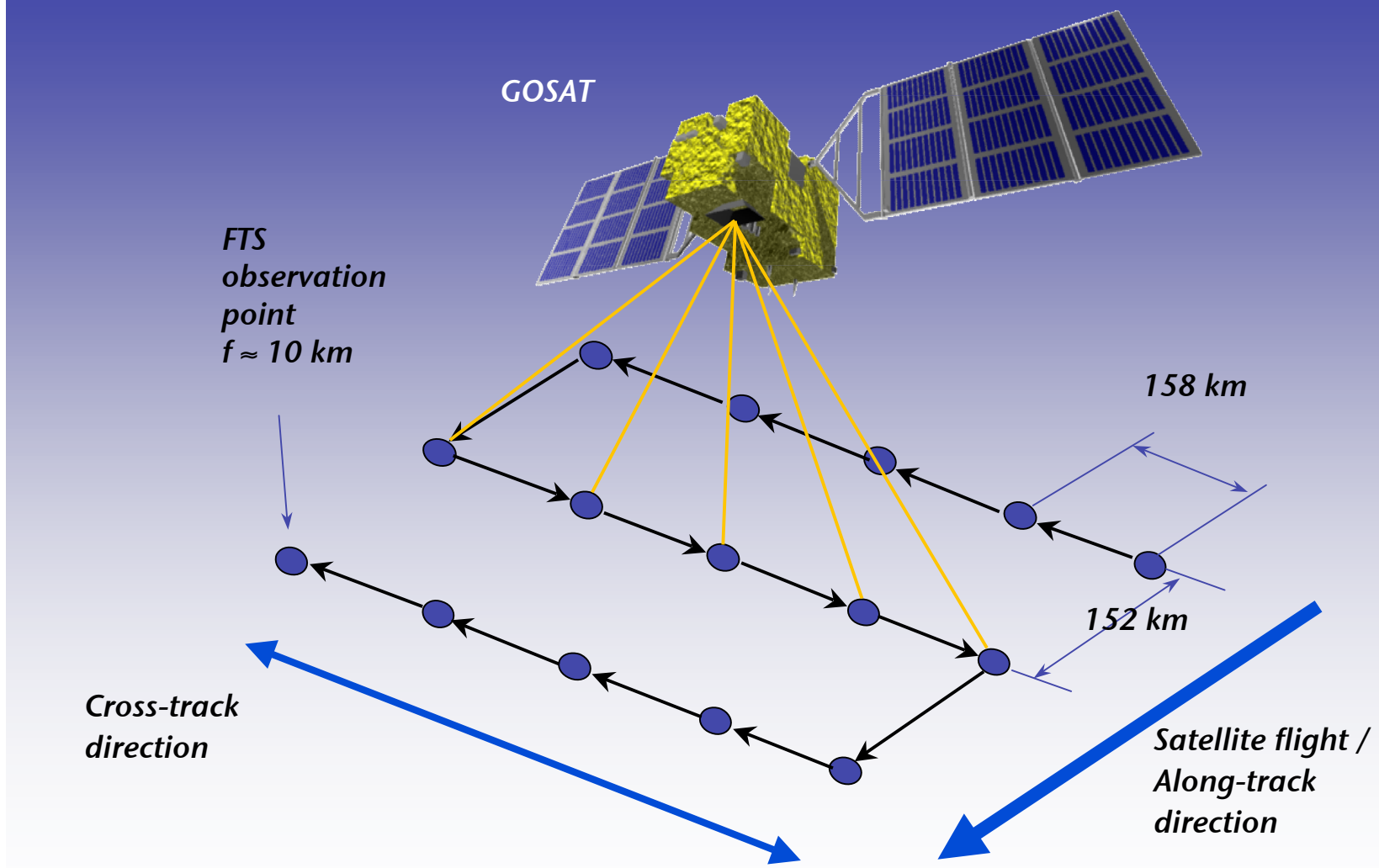
GOSAT Fourier Transform Spectrometer(FTS)



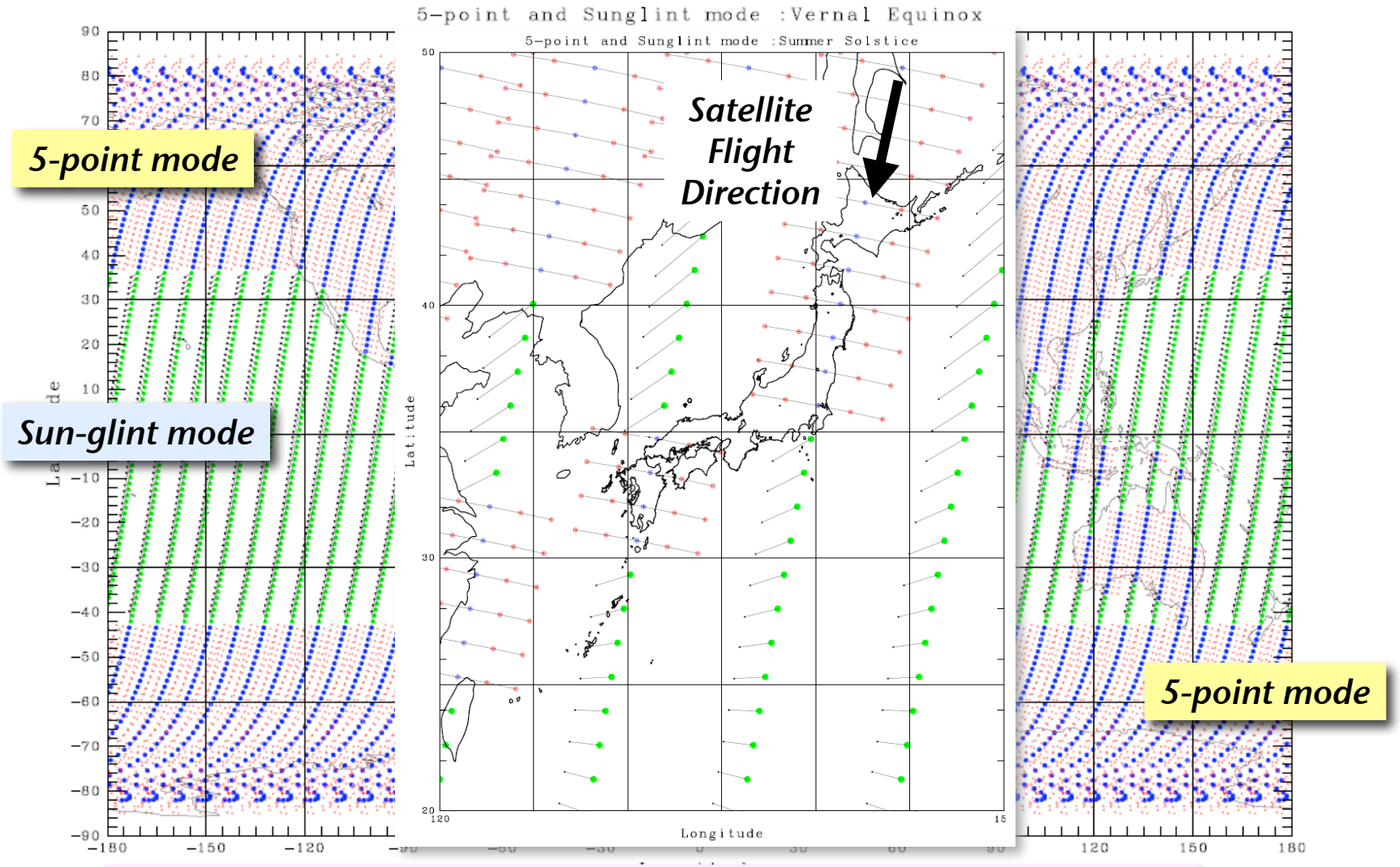
- *FTS will measure sun light mostly reflected at the earth's surface (Band 1-3) and thermal emission both from earth's surface and the atmosphere(Band 4).*
- *Using absorption features in observed spectra, the amount of CO_2 and CH_4 will be calculated.*
- *Band 1-3 are for daytime observation and Band 4 is for both daytime and nighttime.*



GOSAT Observstion over Land : 5-point mode(Latitude = 30°)



Global Observation by GOSAT



In this case, GOSAT is operated in 5-point mode over land and sunglint mode over ocean. Total FTS observation points in 3 days are ≈56,000.

GOSAT Standard Data Products and Release Schedule

Product Level	Sensor	Description
L1B	FTS	Spectrum data obtained by the Fourier transform of Level 1A data
	CAI	Radiance data including parameters for band-to-band registration and geometric correction (before map projection)
L1B+	CAI	Radiance data including parameters for band-to-band registration, geometric correction and map projection
L2	FTS	CO_2 column abundances
		CH_4 column abundances
L3	FTS	CO_2 column concentrations projected on a map (Monthly and quarterly averages)
		CH_4 column concentrations projected on a map (Monthly and quarterly averages)
L4A	-	Amount of CO_2 flux per region, for each of 64 regions (Monthly averages)
L4B	-	CO_2 global distribution data (3D, Monthly averages)

From inverse model

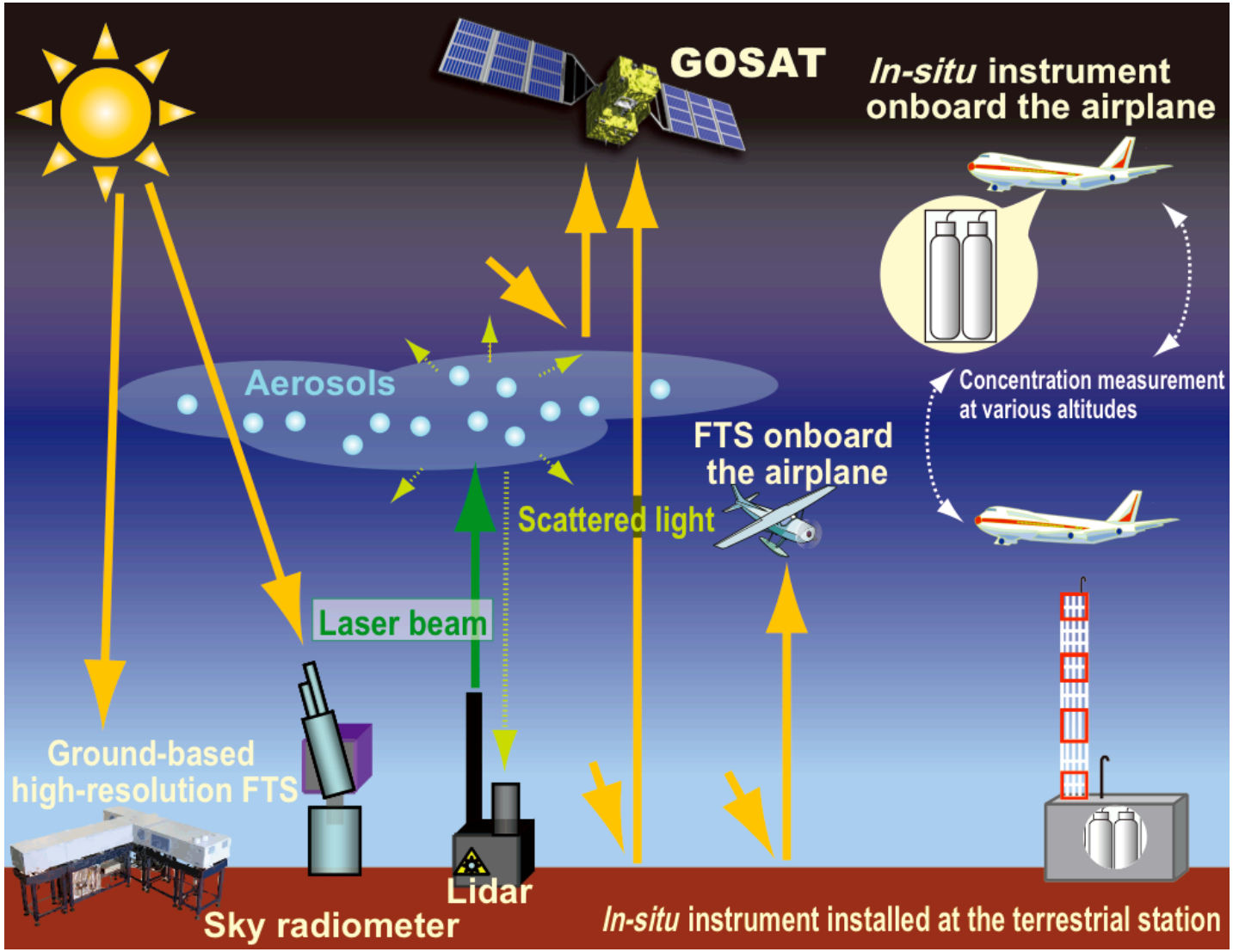
Standard Product Release Schedule for General Users :

- ***L1B*** ***9 months after launch***
- ***L2 and L3*** ***12 months after launch***
- ***L4*** ***2 years after launch (TBD)***

These products will be freely available from NIES GOSAT website(http://www.gosat.nies.go.jp) for non-commercial use.

 # RA researchers will receive limited amount of data prior to general users

Validation of GOSAT Data Products

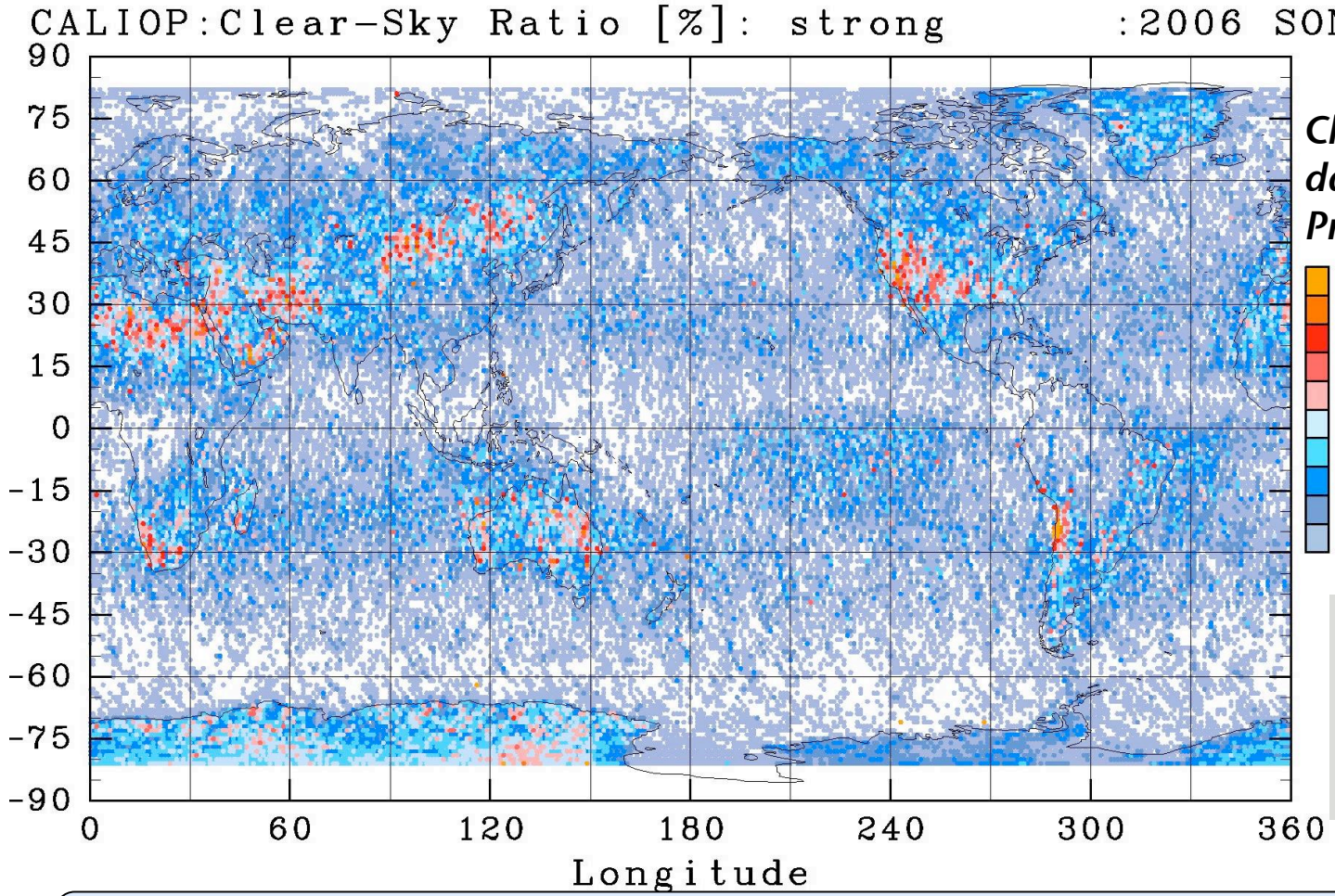


International Collaboration

Domestic Collaboration

To assure the quality/accuracy/precision of GOSAT products, a complehensive validation plan is being discussed.

GOSAT Cloud-free Data Acquisition Probability



Cloud-free data acquisition Probability (%)

100
90
80
70
60
50
40
30
20
10
0

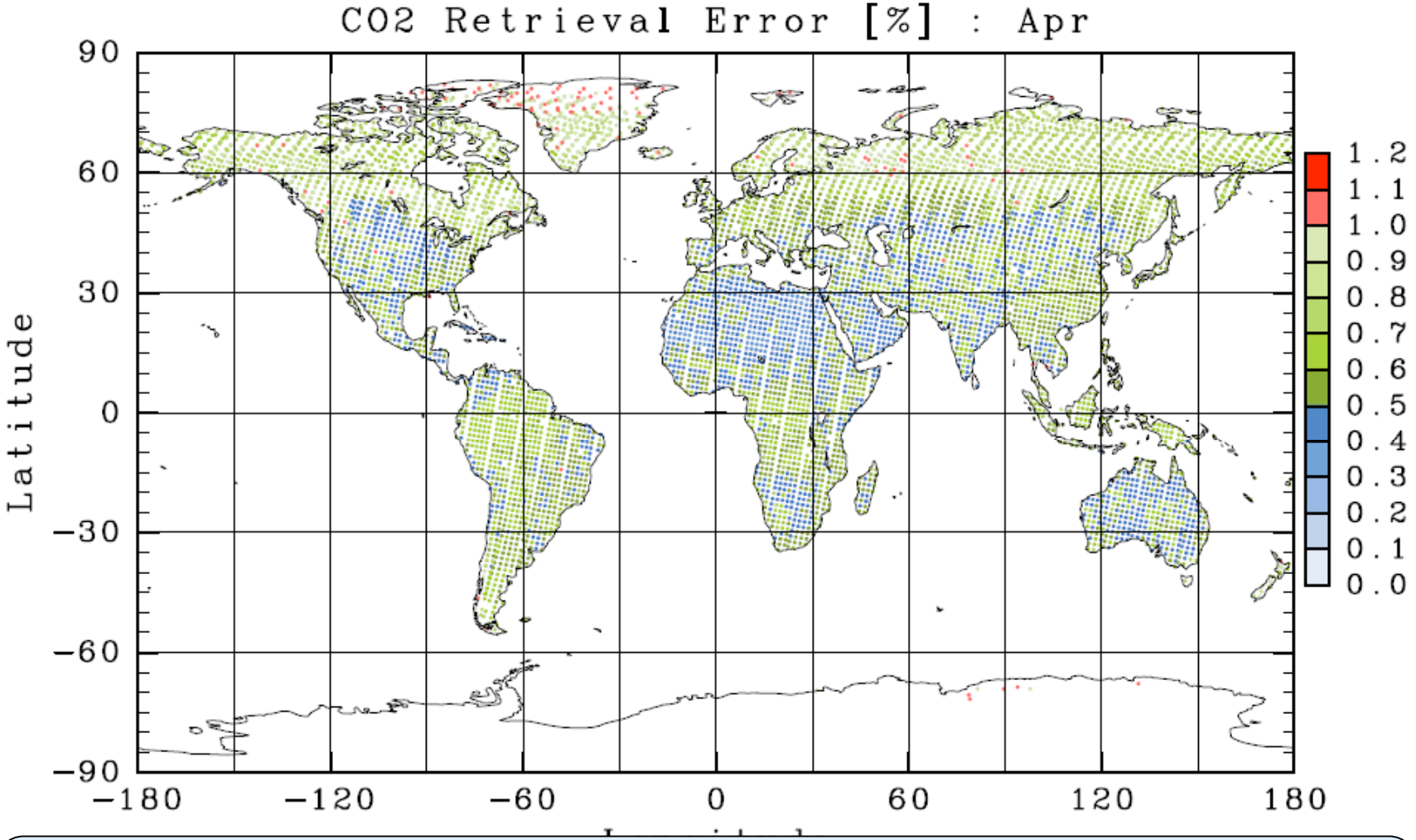
Data : CALIPSO/CALIOP
Season : Oct/Nov/Dec
Grid : 1°
Along-track :10 km

(by N. Eguchi)

- *GOSAT observes same points every 3 days => 56000 points / 3 days*
- *CO2/CH4 retrieval => cloud-free data only* **How many?**

- *Global average of GOSAT cloud-free data acquisition probability is 10-13%*
- *FTS SWIR CO2 over land => 500 - 1000 points / 3 day*

GOSAT CO2 Retrieval Accuracy(SWIR) over Land

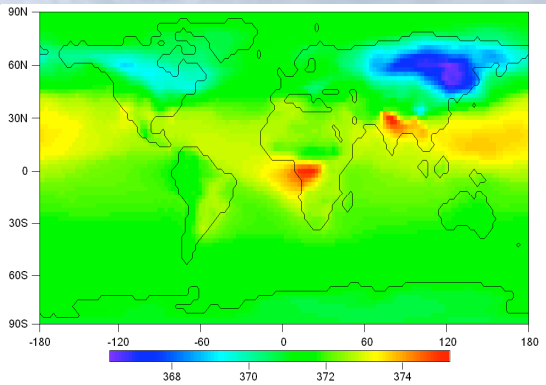


- *Derived CO2 accuracy is a function of surface albedo and solar elevation*
- *High accuracy(≤0.5%) : Low-intermediate latitude / high albedo regions*
- *Low accuracy(1.0%≤) : High latitude / low albedo regions*

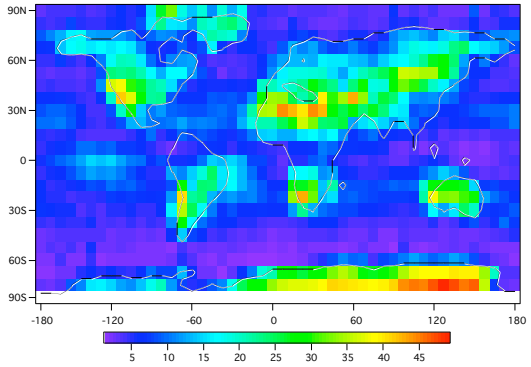
- **GOSAT Level 4A product :**
  Monthly CO2 fluxes of 64 regions from inverse model analysis

- **Maksyutov, et al.*,****
  The effects of GOSAT data to reduce the uncertainty in flux estimation using inverse models were investigated.

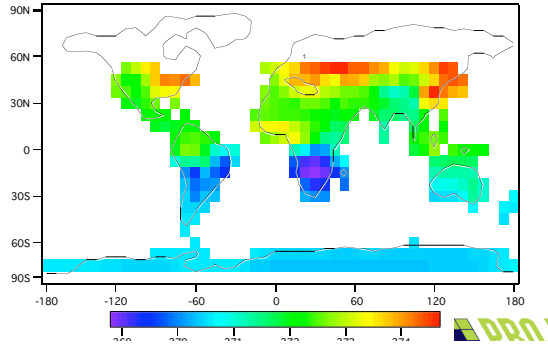
- **Procedures :**
  (1) Simulate gloal column CO2 using NIES tracer transport model.
  (2) Determine the number of GOSAT CO2 data based CALIPSO cloud data.
  (3) Calculate and then aggregate GOSAT CO2 data to monthly 7.5° x 7.5° grid mean.
  (4) Start inverse model calculation with 151 ground data with/without GOSAT data described above.



Simulated total column CO_2 observations in ppm for July 2005.



Annual average probability of clear sky (%) derived from CALIPSO data



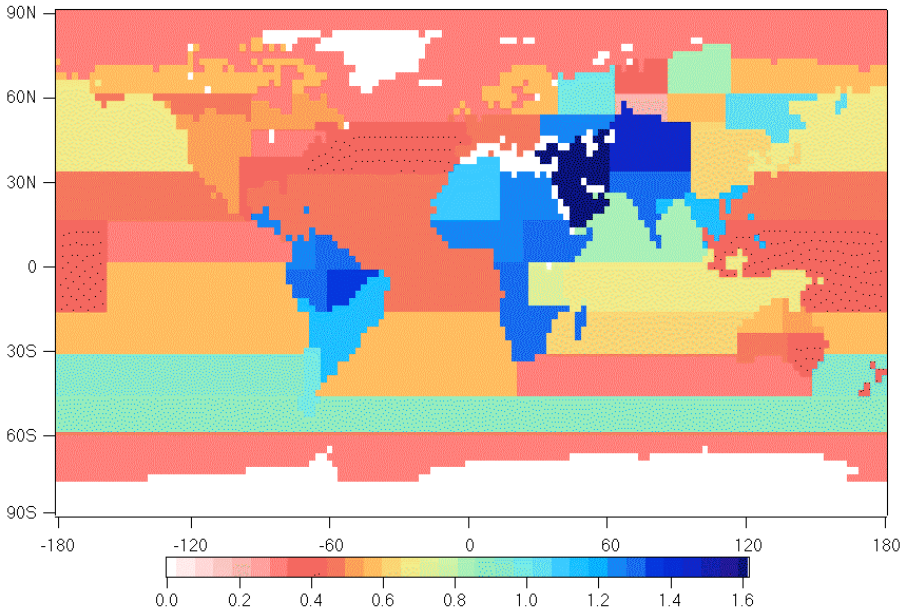
Simulated GOSAT total column CO_2 observations over the land in ppm for monthly mean total CO_2 (bias is 1 ppm) for January 2005

*:Maksyutov et al., Projected impact of the GOSAT observations on regional CO2 flux estimations as a function of total retrieval error, Journal of Remote Sensing Society of Japan, 28, 2, pp. 133-142, 2008.

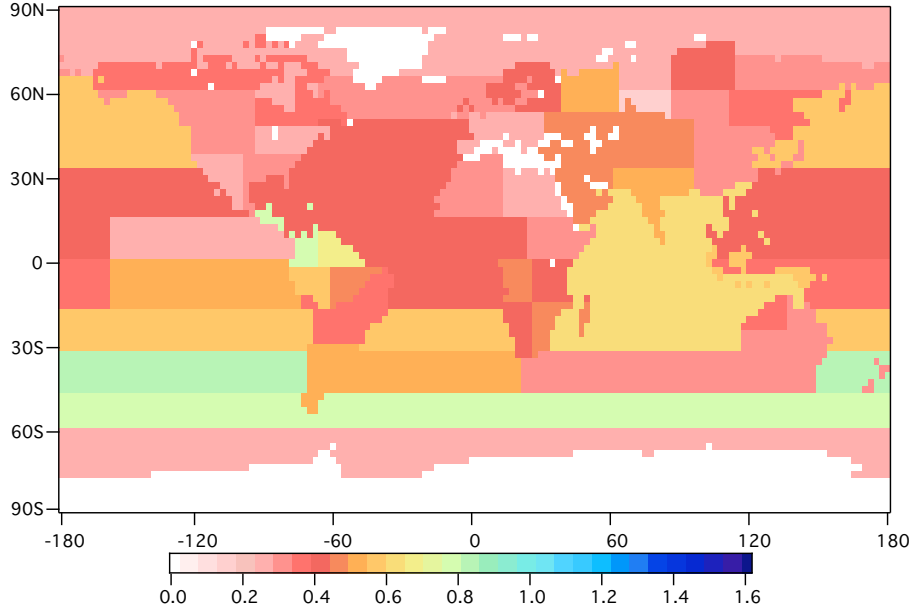
**: Maksyutov, et al., Application of the transport model for inverse model studies of the regional and global budgets of CO2, NIES Supercomputer Annual Report 2006, I078-2008, pp. 23-32, CGER/NIES, 2008.

CO2 fluxes uncertainties in 66 regions (GtC/year/region)

"Surface" network only



GOSAT and "Surface" network



*The **single shot** precision: **2.5 ppm(≈0.8%)** Systematic part of error: 0 ppm*
*Average random error globally: **0.8 ppm** for monthly mean.*

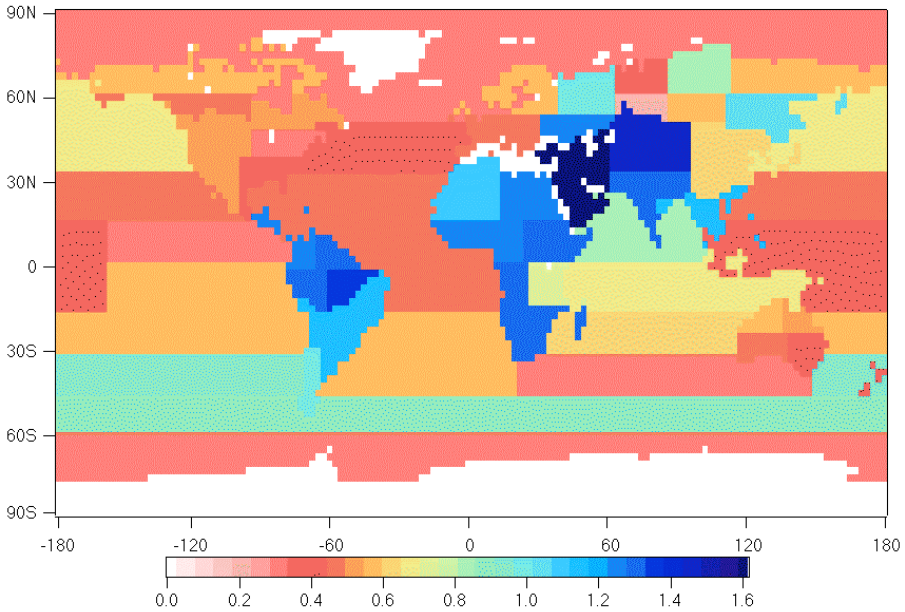
- *The mean regional flux uncertainty can be reduced by about 50% by adding GOSAT observations.*
- *Large reductions are expected for the regions where the numbers of ground measurement stations are small and current flux uncertainities are large such as Amazon, Africa, and a part of Siberia.*

Contribution of GOSAT Data in Reducing Regional CO2 Flux Error

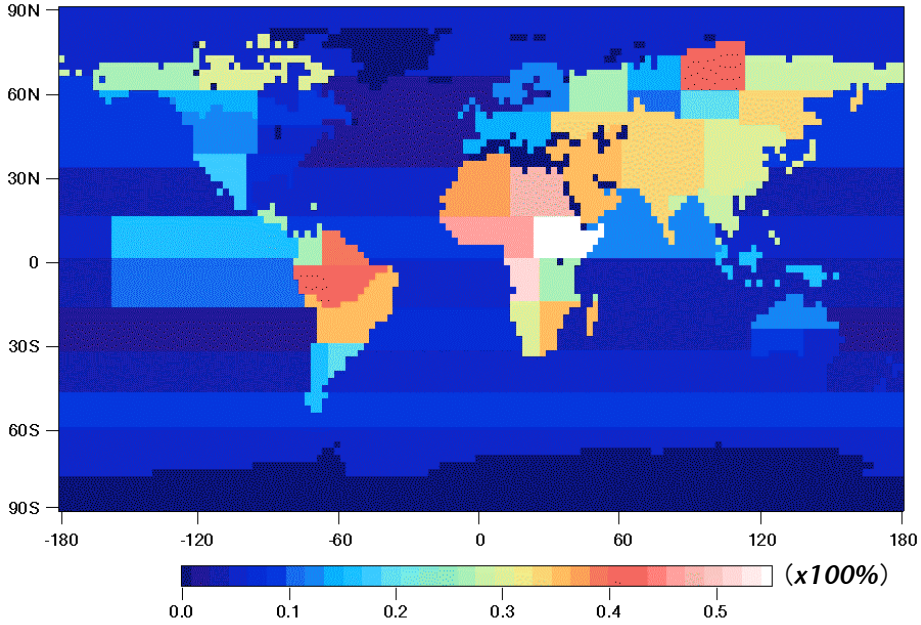
CO2 fluxes uncertainties in 66 regions (GtC/year/region)

Reductions in annual mean CO2 flux uncertainties with GOSAT data

"Surface" network only



GOSAT and "Surface" network



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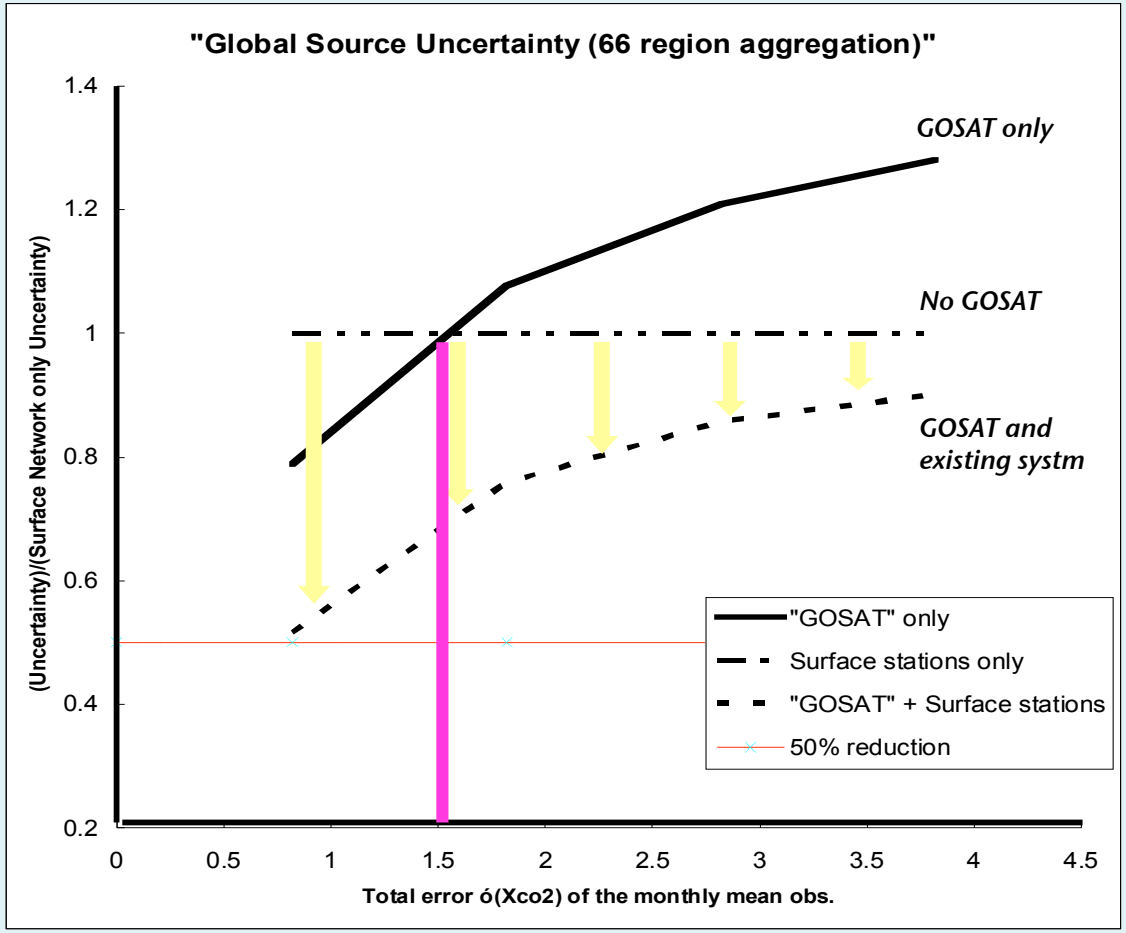
Total uncertainty against the column CO_2 precision data for 66 region case.



Results obtained by using:

- *CALIPSO cloud cover frequency*
- *MODIS albedo in combination with zenith solar angle data used to simulate availbility of observation.*
- *2.5ppm single shot precision for clear-sky retrieval case.*

For 66 region time-dependent inversion, the addition of GOSAT data to existing ground data will reduce the uncertainity upto 10%-50% when GOSAT monthly mean CO2 accuracy is 1 - 3.5ppm.

GOSAT observations with 1.5 ppm monthly-mean precision have the same utility in flux constraining problem as existing CO2 observing system.

Summary

- GOSAT will be launched in FY 2008.
- "500 - 1000 per 3 day" global daytime CO2 column data with the single shot accuracy of 1% or so will be provided to the global community such as GEOSS soon.
- The addition of GOSAT CO2 column data to inverse model analysis will reduce the uncertainity of flux estimation, as much as 50%, especially for regions where ground or other observation network is insufficient.
- GOSAT will fill the data gap of existing GHG monitoring systems!

For Your Information…

GOSAT Research Announcement(RA)

- *Jointly announced by JAXA, NIES, and MOE on April 7, 2008*

- **Research topics:**
  - *(1) Sensor calibration*
  - *(2) Data processing*
  - *(3) Carbon balance estimation, atmospheric transport*
  - *(4) Validation*
  - *(5) Data application*

- **Important dates:**
  - *Proposal deadline: June 30, 2008*
  - *Notification of approval: July 31, 2008*

- **More details:**
  - *Web site: http://www.gosat.nies.go.jp*
  - *Printed version is available at GMGG exhibition booth*

- **Contact:**

GOSAT Project Office, NIES (gosat-prj1@nies.go.jp)

Ministry of the Environment (MOE)

National Institute for Environmental Studies (NIES)

Japan Aerospace Exploration Agency (JAXA)

Greenhouse gases GOSAT PROJECT Observing SATellite

Thank you!